June 3, 1952 S. I. LINDELL ET AL 2,599,187

CIRCUIT INTERRUPTER CONSTRUCTION

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Fig. 1.

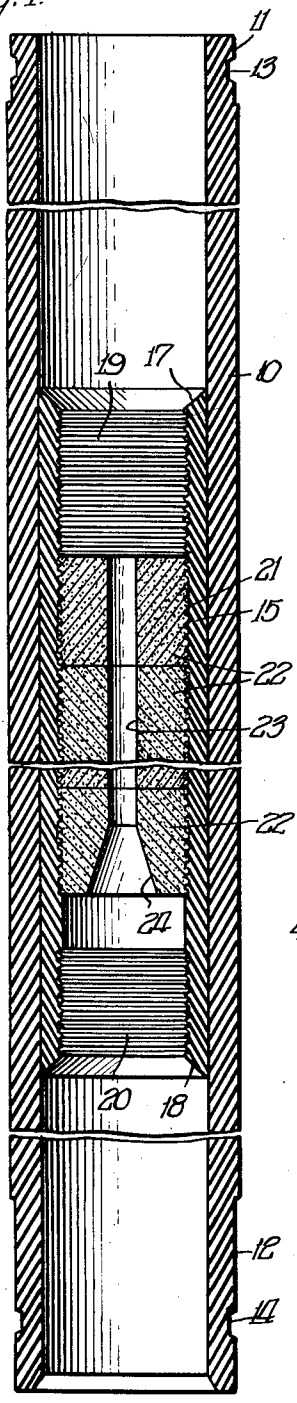


Fig. 2.

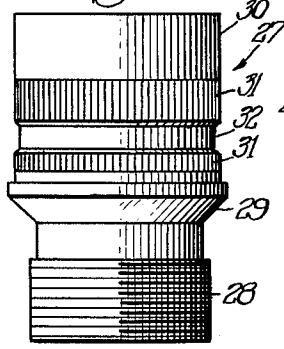


Fig. 3.

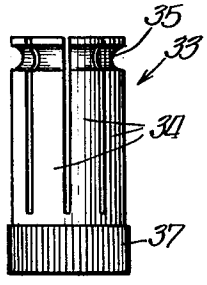


Fig. 4.

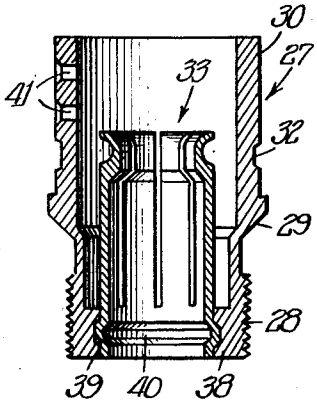


Fig. 5.

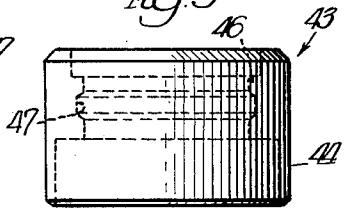


Fig. 6.

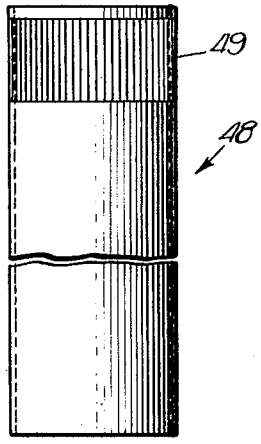
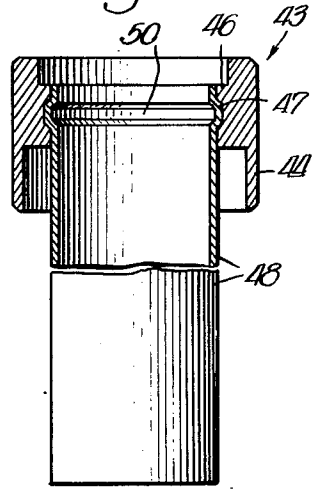


Fig. 7.



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CIRCUIT INTERRUPTER CONSTRUCTION

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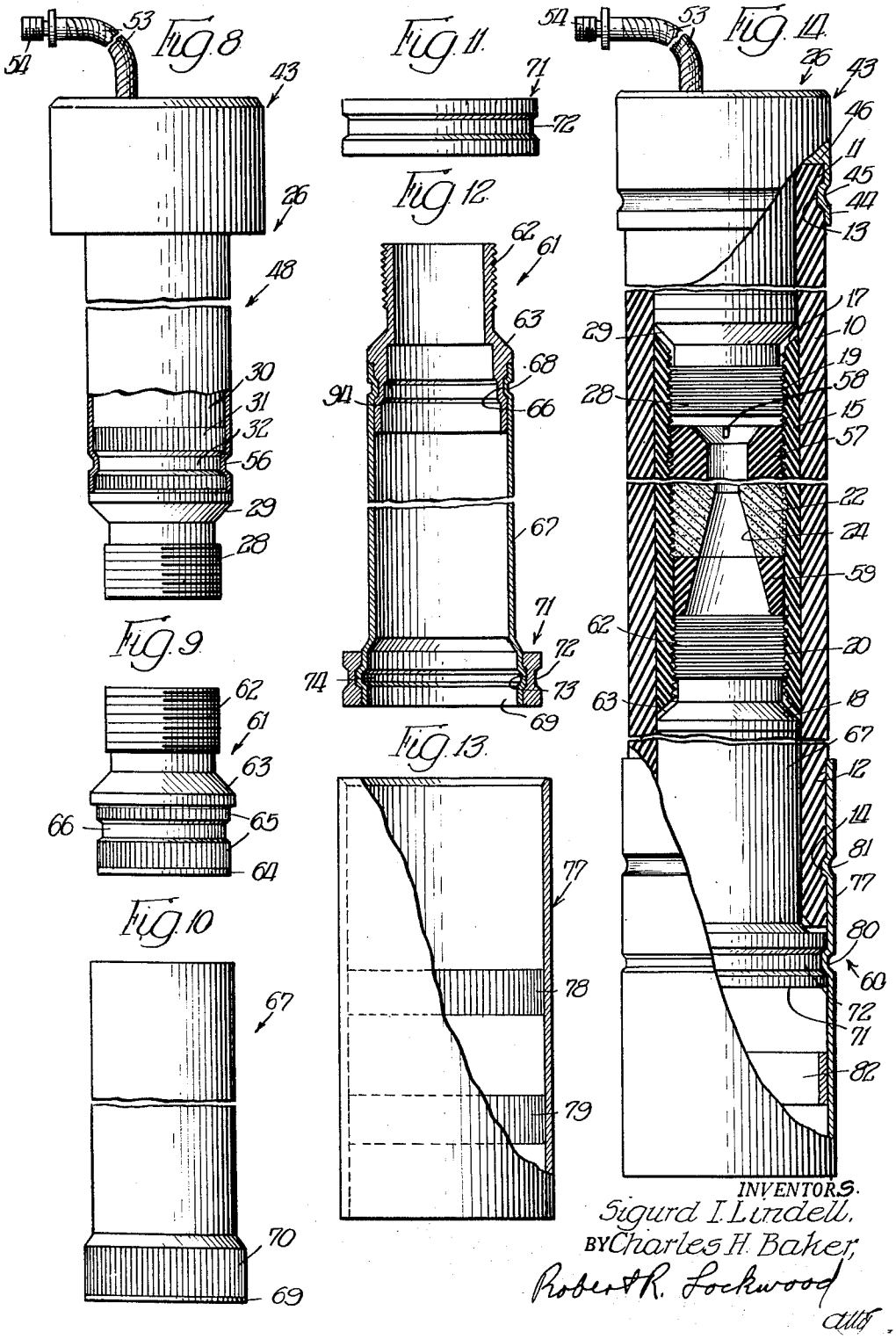

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CIRCUIT INTERRUPTER CONSTRUCTION

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Fig. 15A

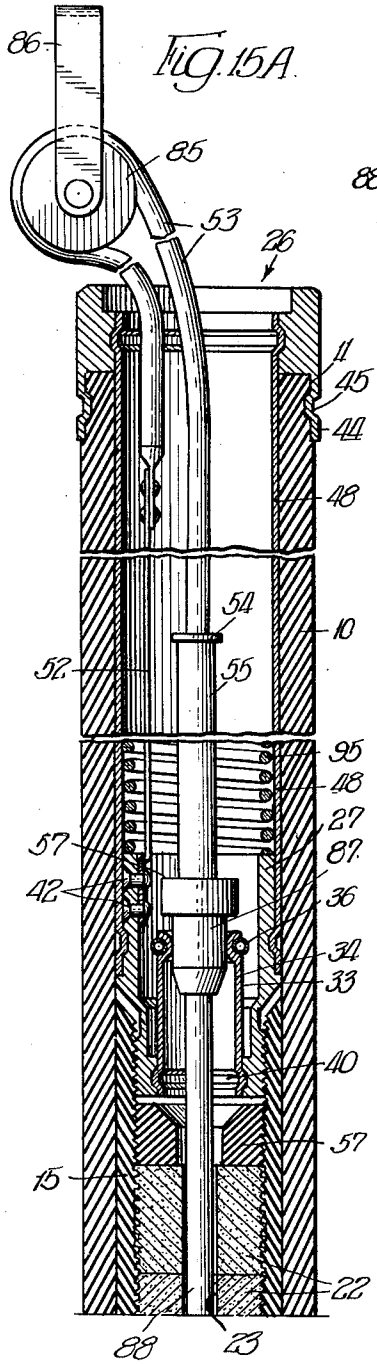


Fig. 15B

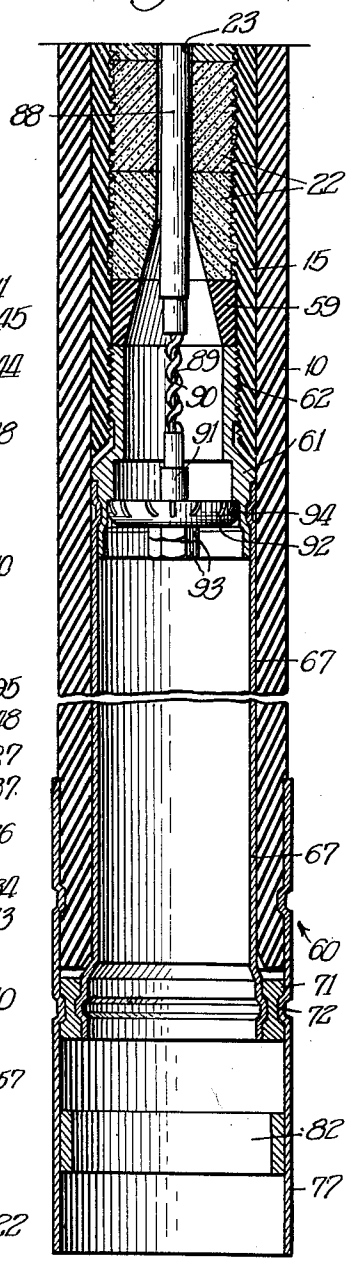
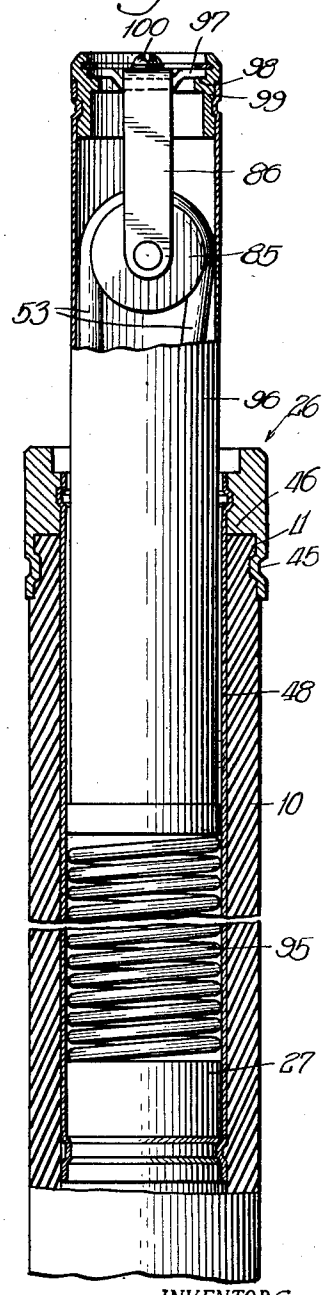


Fig. 16



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UNITED STATES PATENT OFFICE

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CIRCUIT INTERRUPTER CONSTRUCTION

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Application May 28, 1949, Serial No. 96,034

16 Claims. (Cl. 200—120)

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This invention relates generally to circuit interrupters and it has particular relation to circuit interrupters having fusible elements and adapted for use on high voltage transmission lines, such as lines operating at voltages of the order of 34,900 or 69,000 volts. However, it will be understood that the principles of construction disclosed herein can be used for circuit interrupters operating at higher or lower voltages as may be desired. The present invention constitutes certain improvements over that disclosed in application Serial No. 663,832, filed April 22, 1946, now abandoned, by Sigurd I. Lindell and Charles H. Baker and assigned to the assignee of this application. The present invention is intended for use with the dropout fuse construction disclosed in application Serial No. 663,834, filed April 22, 1946, by Sigurd I. Lindell and assigned to the assignee of this application. The present invention may be used with the contact construction disclosed in application Serial No. 57,346, filed October 29, 1948, now Patent No. 2,578,255, dated December 11, 1951, by Sigurd I. Lindell and assigned to the assignee of this application.

Among the objects of this invention are: To balance the mechanical characteristics of the interrupter housing to the end that the interrupting capacity of the device is increased without rupturing any of the parts forming the same; to accomplish this without increasing the weight of the device substantially; to increase the normal current carrying capacity of the interrupter so that it can conduct continuously currents of the order of four hundred amperes without overheating; to provide the largest cross sectional area for the exhaust passage consistent with the minimum wall thickness of the housing; to hold the terminals within a fuse housing against displacement under severe operating conditions and thus increase the interrupting capacity of the device; to provide a lightweight construction which may be handled by a hook stick or similar tool; to accomplish these purposes, in part, by threading the terminals at the ends of the arcing chamber into the lining surrounding the same, the lining having relatively high strength in tension; to secure the various terminals, conducting tubes and retaining members together by mechanical deformation rather than by threading, soldering, or welding; and to secure these parts to the ends of the tubular housing which encloses the same in a similar manner.

Other objects of this invention will, in part, be obvious and in part appear hereinafter.

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This invention is disclosed in the embodiment thereof shown in the accompanying drawings, and it comprises the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the appended claims.

For a more complete understanding of the nature and scope of this invention, reference can be had to the following detailed description, taken together with the accompanying drawings, in which:

Figure 1 is a longitudinal sectional view of a circuit interrupter housing constructed in accordance with this invention having a liner intermediate its ends in which is located a body of arc extinguishing material;

Figures 2 through 8 are views illustrating different parts and different steps in the assembly of the tubular terminal means which is positioned in the upper end of the fuse housing shown in Figure 1;

Figures 9 through 13 are views illustrating different parts and different steps in the assembly of the terminal means which is associated with the lower end of the housing shown in Figure 1;

Figure 14 is a view, partly in side elevation and partly in section showing the upper and lower terminal means assembled in the fuse housing shown in Figure 1;

Figure 15A and Figure 15B, the latter being placed below the former, together constitute a longitudinal sectional view of the fuse housing and terminal means assembled in its ends together with a portion of the operating mechanism for the fuse; and

Figure 16 is a view, partly in side elevation and partly in section, showing an additional portion of the operating mechanism in assembled relation in the fuse housing.

As indicated hereinbefore the present invention is adapted particularly for use in a dropout fuse construction such as that disclosed in the aforesaid application Serial No. 663,834. Since the features and mechanism which have to do with the dropout construction form no part of the present invention, they are not described in detail herein. It will be understood, however, that the present invention can be employed either as a non-dropout fuse or a dropout fuse as may be desired. The present invention has to do particularly with the construction and arrangement of the terminal means at the ends of the tubular fuse housing which are useful in reducing cost of

construction and at the same time reducing the weight of the various parts while providing the necessary mechanical strength and electrical contact engagement between the several conducting parts. The mechanical design characteristics are balanced so that advantage can be taken of the relatively high strength of the housing to resist radial pressure by holding the terminals in position in the ends of the housing in a new and improved manner when the device is subjected to the longitudinal stress incident to interrupting high fault current.

Referring now particularly to Figure 1 of the drawings, it will be noted that the reference character 10 designates a tubular housing which is formed preferably of a phenolic condensation product. Its end sections 11 and 12 are reduced in diameter, as shown, for receiving certain parts of tubular terminal means which will be described in detail hereinafter. These end sections 11 and 12 also have external annular grooves 13 and 14 into which a portion of a flange can be deformed for holding tubular terminal means in fixed position on the ends of the housing 10.

Within the housing 10 there is provided a liner 15 that is formed of relatively high strength insulating material such as fibre which is tough and resilient under conditions of dynamic stress. The liner 15 fits snugly within the housing 10 and it is secured or bonded thereto by suitable adhesive means. It will be noted that the ends 17 and 18 of the liner 15 are beveled or tapered and that these ends are spaced substantial distances from the corresponding ends of the housing 10. The purpose for this construction, as disclosed in the aforesaid application Serial No. 663,832 is to permit the use of a terminal arrangement which will distribute more effectively the electrostatic stress which is developed around the fuse housing 10 during and after circuit interruption.

It will be observed that the ends of the liner 15 are internally threaded as indicated at 19 and 20. The purpose of these threads is to permit the attachment of the tubular terminal means at the ends of the fuse housing 10 directly to the liner 15 so as to place the latter in tension when the former are subjected to longitudinal stress resulting from the operation of the circuit interrupter as will be described hereinafter. Additional special threads 21 are provided on the inner surface of the liner 15 for receiving cakes 22 of arc extinguishing material such as boric acid which is compressed therein as disclosed in the aforesaid Lindell and Baker application. The cakes 22 of arc extinguishing material have a centrally located bore 23 one end 24 of which opens into an outflared throat 24. While it is preferred to use boric acid for the arc extinguishing material within the fibre liner 15, it will be understood that the fibre could be extended radially inwardly to take the place of the cakes 22 and to provide the bore 23.

Referring now particularly to Figures 2 through 8 of the drawings, is will be observed that the reference character 26, Figure 8, designates, generally, one of the two tubular terminal means which are employed in conjunction with the tubular housing 10. The terminal means 26 is intended to be positioned in the upper end of the housing 10 as it is shown in Figure 1 of the drawings, and this assembly is illustrated in Figure 14. The parts making up the tubular terminal means 26 and their method of assembly now will be described.

Referring first to Figure 2, it will be observed that the reference character 27 designates, generally, a relatively thick-walled tubular terminal which may be formed of brass. At its lower end the terminal 27 has external threads 28 which are arranged to be threaded into the threads 19 in the upper end of the liner 15. Intermediate its ends the terminal 27 has a beveled or tapered surface 29 which serves to distribute more uniformly the electrostatic stress referred to above. Also the terminal 27 has a reduced diameter surface 30 at its upper end the lower portion of which is longitudinally knurled as indicated at 31 for a purpose which will be apparent presently. An external annular groove 32 is provided in the knurled surface 31 and its function also will be set forth presently. Within the tubular terminal 27 there is located a contact finger tube, shown generally at 33, that is formed preferably of copper. The tube 33 is shown in Figure 3 and its assembly with the tubular terminal 27 is shown in Figure 4. The contact finger tube 33 includes a plurality of flexible fingers 34 the upper ends or which are curved inwardly as indicated at 35 for receiving a garter spring 36, Figure 15A, and also for making line contact with a contact member which will be described hereinafter.

The lower end of the contact finger tube 33 is knurled longitudinally as indicated at 37 and this knurled portion is arranged to have a press fit with the inner surface of a shoulder 38 which is formed integrally with and extends radially inwardly from the lower end of the tubular terminal 27. The knurled portion 37 having a press fit with the inner surface of the shoulder 38 establishes multiple line contact between these parts. It will be noted that the shoulder 38 has an internal annular groove 39 and that the lower end of the contact finger tube 33 intermediate the knurled surface 37 thereof is radially outwardly deformed thereinto as indicated at 40. The deforming operation is performed preferably by a suitable rolling die.

The knurled and rolled construction just described for interconnecting the contact finger tube 33 and the tubular terminal 37 both mechanically and electrically has several advantages. Because of the longitudinal knurling 37 intimate electrical and mechanical contact engagement is had with the inner surface of the shoulder 38. Multiple line contact under pressure is obtained. At the same time because of this knurling it is unnecessary to maintain very close tolerances between the dimensions of these parts and it is still possible to obtain the desired close electrical and mechanical engagement therebetween by a press fit without requiring that the usual close tolerances be maintained where the knurling is omitted. By deforming the knurled surface 37 as indicated at 40 into the internal annular groove 39, the contact finger tube 33 is fixed securely in place in the tubular terminal 37. It will be apparent that this method of joining the contact finger tube 33 to the tubular terminal 27 requires no threads and no soldering or welding and that high mechanical strength and good electrical contact are obtained. If desired, the parts may be silver plated in order to further improve the conducting characteristics of the joint therebetween. It will be understood that this method of assembly is employed for joining other metallic parts with the same advantages and this will be apparent as the description proceeds.

It will be noted in Figure 4 that the tubular terminal 27 has two openings 41 extending

through its wall near the upper end. These openings 41 are provided for receiving rivets 42, Figure 15A, by which one end of a conducting strap may be secured as will be described hereinafter.

As shown in Figure 5 a retaining member or ferrule 43 is provided which may be formed of brass and may have relatively thick walls. Formed integrally with the retaining member or ferrule 43 is a flange 44 which, as shown in Figure 15A, telescopes over the reduced diameter end section 11 of the housing 10. The flange 44 is deformed by suitable rolling die, as indicated at 45, for holding the retaining member or ferrule 43 and the parts attached thereto firmly to the upper end of the housing 10.

As illustrated in Figures 5 and 7, the retaining member or ferrule 43 has a radially inwardly extending shoulder 46 in which is located an internal annular groove 47. The shoulder 46 is provided for receiving the upper end of a relatively thin-walled metallic tube 48, Figures 6 and 7, which is formed preferably of copper. The upper end of the tube 48 is longitudinally knurled as indicated at 49 for the purpose described hereinbefore and this portion of the tube 48 has a press fit with the inner surface of the shoulder 46. In addition the upper end of the metallic tube 48 is deformed, as indicated at 50, by rolling the same into the groove 47. The assembly is shown in Figure 7 and it will be understood that the combination of the longitudinal knurling 49 and the rolling of the upper end of the tube 48 into the groove 47 provides the desired mechanical and electrical interconnection between these parts which has the advantages outlined above. The tube 48 has relatively high strength and has current carrying capacity sufficient for normal load current of the order of four hundred amperes.

The next step in the assembly is to secure a strap 52, Figure 15A, by the rivets 42 to the tubular terminal 27. The strap 52 has a flexible conductor 53 attached thereto which has a threaded terminal 54, Figure 8, at one end to facilitate connection to a rod-like terminal 55, Figure 15A, which, as will appear hereinafter, is arranged to be moved longitudinally through the bore 23 in the cakes 22 of arc extinguishing material. Now the metallic tube 48, assembled therewith as shown in Figure 7, is telescoped over the reduced diameter surface 30 of the tubular terminal 27 as illustrated in Figure 8. Thereafter the lower end of the tube 48 is deformed as indicated at 56 by a suitable rolling die so that the groove 32 is filled by the deformed portion of the lower end of this tube. Here again there is the combination of the longitudinally knurled surface 31 and the deformed thin-walled metallic tube 48 into the groove 32 which provides the desired electrical and mechanical interconnection between the parts. Its advantages have been outlined above and will not be repeated.

Referring now to Figure 14 it will be observed that a plug 57 of suitable insulating material, such as a phenolic condensation product, having a kerf 58 is screwed into the threads 19 for abutting the lowermost cake 22 of insulating material. The plug 57 provides a stop against which the cakes 22 of boric acid can be compressed and held in position. At the other end of the liner 15 an exhaust ring 59, of suitable insulating material such as fibre, bears against the lowermost cake 22 of arc extinguishing material which has the outflared throat 24 and compression stress is transmitted therethrough, as will appear hereinafter, to hold the cakes 22 of boric acid in compression. Now the tubular terminal means 26, which has been assembled in the manner described hereinbefore and which is shown in Figure 8, is inserted in the upper end of the tubular housing 10 and the threads 28 are screwed into the threads 19 until the lower surface of the shoulder 46 abuts the upper end of the tubular housing 10 as shown in Figure 14. Thereafter the flange 44 is deformed as indicated at 45 so that it interfits with the annular groove 13 and thus securely holds the assembly in place in the tubular housing 10.

In Figure 14 it will be noted that the reference character 60 designates, generally, tubular terminal means for the lower end of the tubular housing 10. The parts making up this terminal means 60 and their method of assembly are illustrated in Figures 9 through 13.

As shown in Figure 9, there is a relatively thick-walled tubular terminal 61, preferably formed of brass, which is similar in construction to the tubular terminal 27 previously described. The tubular terminal 61 is threaded as at 62 and these threads are arranged to engage the threads 20 at the lower end of the liner 15. The terminal 61 has a beveled or tapered surface 63 which is juxtaposed with the beveled or tapered end 18 of the liner 15, as shown in Figure 14, and serves, as previously described, to assist in more uniformly distributing the electrostatic stress during and after circuit interruption. There is a reduced diameter outer surface 64 at the lower end of the terminal 61 and this surface is longitudinally knurled at 65. Intermediate the knurling 65 is an external annular groove 66. The terminal 61 is arranged to be secured to the upper end of a relatively thin-walled metallic tube, shown generally at 67, which is formed preferably of copper. The tube 67 corresponds generally to the metallic tube 48 described hereinbefore and has relatively high tensile strength and current carrying capacity. It is shown in Figure 10 and in Figure 12 its assembly with the terminal 61 is shown. It will be noted there that the upper end of the tube 67 is telescoped over the reduced diameter surface 64 of the terminal 61 and that it is deformed as indicated at 68 so as to fill the annular groove 66. Here again the combination of the longitudinal knurling 65 and the annular groove 66 with the upper end of the tube 67 deformed thereinto provides the desired mechanical and electrical interconnection between the parts having the advantages previously noted.

The lower end 69 of the tube 67 is enlarged, as by spinning, and its outer surface is longitudinally knurled as indicated at 70. This knurled surface 70 is arranged to interfit with a retaining member, shown generally at 71, in Figure 11, which is ring-like in shape and is formed preferably of brass. The retaining member 71 has an outer annular groove 72 and an inner annular groove 73, Figure 12. As here shown the retaining member 71 is telescoped over the knurled surface 70 and the lower end of the tube 67 is deformed, as indicated at 74, into the inner annular groove 73. This arrangement provides the desired mechanical and electrical connection between the parts having the advantages outlined hereinbefore.

Referring to Figure 14, it will be observed that at the lower end of liner 15 the fibre exhaust ring 59 is placed against the lowermost cake 22 of arc extinguishing material which has the out-

flared throat 24. The assembly of the tubular terminal 61, metallic tube 67 and retaining member 71 is then placed in the housing 10 with liner 15 so that threads 62 of the tubular terminal 61 engage inner threads 20 of the fibre liner. This assembly then is rotated until pressure is exerted upon the fibre exhaust ring 59 and lowermost insulating cake 22 to provide a unitary assembly the inner surface of which is smooth and will not impede the flow of gases from the bore 23, and which assembly prevents breakage of the cakes 22 of boric acid.

Instead of providing the retaining member 71 with an integrally formed flange, such as the flange 44, Figure 5, which forms a part of retaining member 43, there is provided a separate member in the form of an exhaust ferrule or tube, preferably formed of brass, and illustrated generally at 77 in Figure 13. The exhaust ferrule or tube 77 has internally spaced apart longitudinally knurled surfaces 78 and 79. As shown in Figure 14 the exhaust ferrule or tube 77 is arranged to be telescoped over the retaining member 71 and over the end section 12 of the lower end of the tubular housing 10 so that the knurled portion 78 of the ferrule or tube 77 engages the external surface of 71 and the uppermost inner surface of ferrule or tube 77 is in press fit contact with the external surface of housing 10. Thereafter the exhaust ferrule or tube 77 is deformed as indicated at 80 and 81 by a suitable rolling die so as to interfit with the annular outer groove 72 of the retaining member 71 and groove 14 in the housing 10. Here again it is pointed out that the desired mechanical and electrical connection between the parts 77 and 71 is provided by the combination of the knurled surface 78 and the deformed portion 80 of the exhaust ferrule or tube 77 into the annular groove 72.

With a view to providing additional body for the exhaust ferrule or tube 77 so as to facilitate the attachment thereto of suitable terminal fittings by screws or the like, a bushing 82, preferably in the form of a brass ring, is inserted therein and has a press fit with the longitudinally knurled surface 79. It will be understood that the bushing 82 is assembled in the outer ferrule or tube 77 prior to its assembly with the retaining member 71 and tubular housing 10.

The tubular housing 10 with the tubular terminal means 26 and 60 assembled therein, as shown in Figure 14, constitutes a subassembly in the steps leading up to the complete assembly of the circuit interrupter. Next the flexible conductor 53 is threaded over a pulley 85, Figure 15A, which is carried by a pulley yoke 86. The terminal 54 is threaded into the upper end of the rod-like terminal 55 which has a cylindrical contact section 87 for engaging the upper ends of the contact fingers 34 of the contact finger tube 33. The lower end 88 of the rod-like terminal 55 is reduced somewhat in diameter, as shown, and it extends through the bore 23 in the cakes 22 of arc extinguishing material. At its lower end the section 88 is connected by a strain wire 89 and a fusible wire 90 to a terminal 91 which projects through a spider 92 and is secured thereto by nuts 93. The spider 92 is formed of a suitable high conductivity material having resilient qualities, such as hard drawn copper, and it bears against a shoulder 94 on the tubular terminal 61 as shown. It will be understood that the spider 92 is not rigidly attached to the terminal 61 so that, when sufficient pressure is generated as a result of the blowing of the fusible and strain wires 89 and 90, the spider 92 and the terminal 91 are blown outwardly through the metallic tube 67.

A coil compression spring 95 now is telescoped over the pulley yoke 86, pulley 85 and flexible conductor 53, as shown in Figure 15A. Thereafter a compression tube 96 is telescoped over these same elements and is inserted into the metallic tube 48 at the upper end of the tubular housing 10 as shown in Figure 16. By means of a suitable tool the pulley yoke 86 is held in an upright position while the compression tube 96 is moved inwardly to compress the spring 95 and is moved sufficiently far so as to permit the insertion of a pulley bar 97 underneath the upper end of the yoke 86 which, when released, bears against a shoulder 98 of an end ring 99 that is carried by the upper end of the compression tube 96. A screw 100 serves to rigidly interconnect the pulley yoke 86 and the pulley bar 97. It will be understood that the coil compression spring 95, acting through the compression tube 96 and the pulley 85, places the flexible conductor 52 under tension. This tension is transmitted by the rod-like terminal 55 to the strain element 89, Figure 15B, which in turn transmits it to the terminal 91 that is carried by the spider 92. The spider 92, since it reacts against the shoulder 94 of the tubular terminal 61, holds the spring 95 in the compressed position as shown in Figure 16.

When the circuit interrupter, described hereinbefore, is subjected to a predetermined overload sufficient to cause the blowing of the fusible wire 90 and thereafter the strain wire 89, the spring 95 no longer is restrained and it moves the compression tube 96 upward. This causes the rod-like terminal 55 and its reduced diameter section 88 to move upwardly through the bore 23 at a speed which is twice that of the movement of the compression tube 96. The arc is drawn and extended into the bore 23 in a manner well known and arc extinguishing material is evolved from its walls which serves to deionize the arc space and to assist in extinguishing the arc. If the pressure is great enough, the terminal 91 and the spider 92 will be blown out of the metallic tube 67.

It will be understood that the retaining member or ferrule 43 and the exhaust ferrule or tube 77 are arranged and constructed so as to receive fittings, such as those disclosed in application Serial No. 663,834 referred to above, for mounting the device in a dropout fuse mounting. As there disclosed, provision can be made for utilizing the upward movement of the compression tube 96 to unlatch the device and permit it to swing downwardly to an open position. Also it will be understood that the exhaust ferrule or tube 77 is located at the lower or hinge end of such a dropout device and it is for this reason that the special construction thereof described hereinbefore is employed.

For illustrative purposes it is pointed out that, for a 69,000 volt circuit interrupter, the tubular housing 10 may be $35\frac{11}{16}$ inches long, with an outside maximum diameter of $2\frac{3}{8}$ inches and an internal diameter at the ends varying from 1.682 to 1.713 inches. The fibre tube 15 is nineteen inches long. The terminal means 26 extends into the housing 10 from the top $12\frac{1}{4}$ inches and the terminal means 60 extends into the housing 10 from the bottom $7\frac{11}{16}$ inches.

As indicated hereinbefore the housing 10, with the parts assembled therein as shown and described, is supported by the exhaust ferrule or tube 77 on the dropout mounting therefor. It is

this lower end of the housing 10 that is held stationary when the device operates. When a fault current of a relatively high magnitude is interrupted, the exhaust blast through the bore 23 and the tube 67 reacts like a jet in a jet propulsion device. Since the housing 10 is fastened at its lower end and the terminal means 26 and 60 are held in place, the resulting upward thrust causes a tension stress to be developed in the housing 10 and in the fibre liner 15. At the same time force is applied radially of the boric acid cakes 22 and the fibre liner 15. Because of the tough and resilient character of the latter, this radial force is resisted. The terminal means 26 and 60 are prevented from being torn off since the tubular terminals 27 and 61 thereof are threaded into the fibre liner 15 and the flange 44 and the ferrule 77 are secured to the ends of the housing 10 in the grooves 13 and 14 as described. The cakes 22 of boric acid are held stationary and in compression by this construction. This is important since arc extinguishing gas is evolved from the bore 23 and it is most effective when it intimately contacts the arc drawn from the lower end 33 of the receding terminal 55.

Under severe interrupting conditions, the rod-like terminal 55 is driven upwardly at high speed. Its movement is arrested and the kinetic energy thereof dissipated through force transmitted to the housing 10 and liner 15 through the tubular terminal means 26. This force adds to the previously described force resulting from jet action in developing the tension stress in the housing 10 and liner 15. Also under such operating conditions the bore 23 may become eroded as a result of the flow of several cycles of arc current and the blast action thereon develops additional endwise thrust.

Under certain operating conditions the arc may restrike in the bore 23 after it has once been extinguished. An abrupt generation of pressure results which is accompanied by severe longitudinal and radial stresses being created in the housing 10 and liner 15.

The circuit interrupter constructed and assembled as described is capable of withstanding these stresses without disintegration for values of fault current greatly exceeding those which can be interrupted by devices not so made. Further the present invention provides the largest possible cross section for the exhaust opening through the tube 67 of the lower terminal means 60 consistent with the minimum wall thickness of the housing 10 so as to control the dielectric stress in the surrounding air as described in the aforesaid application of Lindell and Baker. A similar relationship is provided for the tube 48, which forms a part of the upper terminal means 26, and the adjacent portion of the housing 10.

Since certain changes can be made in the foregoing construction and different embodiments of the invention can be made without departing from the spirit and scope thereof, it is intended that all matter shown in the accompanying drawings and described hereinbefore shall be interpreted as illustrative and not in a limiting sense.

What is claimed as new is:

1. In a high voltage circuit interrupter, in combination, a tubular housing of insulating material, a liner of insulating material inside of and secured to said housing, tubular terminal means extending into each end of said housing with its inner end threaded into said liner, and means for drawing and extinguishing an arc in said liner including means capable of evolving a gaseous arc extinguishing medium due to the heat of the arc which expands endwise of said liner, the internal forces resulting from pressure generated by said gaseous arc extinguishing medium on circuit interruption tending to separate said tubular terminal means and place said liner in tension being resisted by the aforesaid construction whereby said terminal means are held stationary and the interrupting capacity is increased.

2. In a high voltage circuit interrupter, in combination, a tubular housing of insulating material, a liner of insulating material inside of and secured to said housing; tubular terminal means extending into each end of said housing and comprising an externally threaded tubular terminal threaded into said liner, and a metallic tube telescoped at its inner end with and mechanically secured to said tubular terminal; and means for drawing and extinguishing an arc in said liner including means capable of evolving a gaseous arc extinguishing medium due to the heat of the arc which expands endwise of said liner, the internal forces resulting from pressure generated by said gaseous arc extinguishing medium on circuit interruption tending to separate said tubular terminal means and place said liner in tension being resisted by the aforesaid construction whereby said terminal means are held stationary and the interrupting capacity is increased.

3. In a high voltage circuit interrupter, in combination, a tubular housing of insulating material, a liner of insulating material inside of and secured to said housing; tubular terminal means extending into each end of said housing and comprising an externally threaded tubular terminal threaded into said liner, and a metallic tube telescoped at its inner end with and mechanically secured to said tubular terminal and extending out of the corresponding end of said housing; means securing the projecting end of each metallic tube to said housing, and means for drawing and extinguishing the arc in said liner including means capable of evolving a gaseous arc extinguishing medium due to the heat of the arc which expands endwise of said liner, the internal forces resulting from pressure generated by said gaseous arc extinguishing medium on circuit interruption tending to separate said tubular terminal means and place said liner in tension being resisted by the aforesaid construction whereby said terminal means are held stationary and the interrupting capacity is increased.

4. In a high voltage circuit interrupter, in combination, a tubular housing of insulating material having an external annular groove near each end, a liner of insulating material inside of and secured to said housing with its ends internally threaded and spaced from the ends of said housing; tubular terminal means extending into each end of said housing and comprising an externally threaded tubular terminal threaded into the corresponding end of said liner, a metallic tube telescoped at its inner end with and mechanically secured to said tubular terminal and extending out of the corresponding end of said housing, and a retaining member telescoped with and mechanically secured to the end of said tube projecting from said housing and having a flange telescoped with the corresponding end of said housing and interfitting with the external annular groove thereat; and means for drawing and extinguishing an arc in said liner including means capable of evolving a gaseous arc extinguishing medium due to the heat of the arc which expands endwise of said liner, the endwise thrust

resulting from pressure generated by said gaseous arc extinguishing medium on circuit interruption being applied to said tubular terminals and transmitted thereby to said housing and said liner to place both in tension whereby said terminals are held stationary and the interrupting capacity is increased.

5. The invention, as set forth in claim 4, wherein a portion of the external surface of each tubular terminal coextensive with the metallic tube and a portion of the external surface of each metallic tube coextensive with each retaining member is knurled and the parts have a press fit.

6. The invention, as set forth in claim 5, wherein each tubular terminal has an external annular groove in the knurled portion into which the metallic tube is deformed and each retaining member has an internal annular groove into which an intermediate part of the knurled surface of said metallic tube is deformed.

7. The invention, as set forth in claim 4, wherein each retaining member is annular with an internal annular groove into which the associated metallic tube is deformed and has a flange telescoped with the adjacent end of the tubular housing and deformed into the annular groove thereof.

8. The invention, as set forth in claim 7, wherein the flange constitutes an integral part of one retaining member and is separate from the other retaining member, and said other retaining member has an external annular groove into which its flange is deformed.

9. In a high voltage circuit interrupter, in combination, a tubular housing of insulating material having an external annular groove near each end, a liner of insulating material inside of and bonded to said housing with its ends internally threaded and spaced from the ends of said housing; tubular terminal means extending into each end of said housing and comprising an externally threaded tubular terminal threaded into the corresponding end of said liner, a metallic tube telescoped at its inner end with and mechanically secured to said tubular terminal and extending out of the corresponding end of said housing, and a retaining member telescoped with and mechanically secured to the end of said tube projecting from said housing and having a flange telescoped with the corresponding end of said housing and interfitting with the external annular groove thereat; a body of arc extinguishing material within said lining having a bore therethrough from which a gaseous arc extinguishing medium is evolved due to the heat of the arc which expands endwise of said liner, an expellable terminal bearing against one of said tubular terminals and adapted to be blown through its metallic tube on operation of the interrupter, a rod-like terminal extending through said bore, fusible means interconnecting said expellable terminal and said rod-like terminal, flexible conducting means interconnecting said rod-like terminal and the other of said tubular terminals, and spring means cooperating with said flexible conducting means to move said rod-like terminal through said bore when said fusible means blows, the endwise thrust resulting from pressure generated by said gaseous arc extinguishing medium on blowing of said fusible means being applied to said tubular terminals and transmitted thereby to said housing and said liner to place both in tension whereby said terminals are held stationary and the interrupting capacity is increased.

10. In a high voltage circuit interrupter for use with electric power systems wherein the transient recovery voltage may be substantially greater than the normal frequency recovery voltage, in combination, a tubular housing of insulating material having an arcing passageway spaced from each end a distance several times the diameter of said housing, terminals at the ends of said housing for connection to the circuit and between which said recovery voltages are applied, a stationary metallic extension from each of said terminals inside said housing extending to the adjacent end of said arcing passageway, an insulating tension member within said tubular housing mechanically interlocked at its ends to the inner ends of said extensions to prevent expulsion of the same from said housing, and means for drawing an arc in said passageway on operation of the interrupter, said extensions acting to distribute electrostatic stress between said terminals after interruption of current flow therebetween and prevent the dielectric strength of said arcing passageway from rising above that of any external parallel path between said terminals.

11. The invention, as set forth in claim 10, wherein the extensions are tubular and the insulating means mechanically interconnecting them is a tube.

12. In a high voltage circuit interrupter for use with electric power systems wherein the transient recovery voltage may be substantially greater than the normal frequency recovery voltage, in combination, a tubular housing of insulating material having an arcing passageway spaced from each end a distance several times the diameter of said housing, terminals at the ends of said housing for connection to the circuit and between which said recovery voltages are applied, a tubular stationary metallic extension from each of said terminals inside said housing extending to the adjacent end of said arcing passageway, an insulating tube having threaded connection at its ends to the inner ends of said tubular metallic extensions to prevent expulsion of the same from said housing, and means for drawing an arc in said passageway on operation of the interrupter, said extensions acting to distribute electrostatic stress between said terminals after interruption of current flow therebetween and prevent the dielectric strength of said arcing passageway from rising above that of any external parallel path between said terminals.

13. In a high voltage circuit interrupter, in combination, a relatively long tubular housing of insulating material, a relatively short tough and resilient liner of insulating material within and substantially midway between the ends of and secured to said tubular housing, a tubular terminal extending into each end of said housing with the inner end of each terminal mechanically interlocked with the adjacent end of said liner and the outer end of each terminal mechanically interlocked with the adjacent outer end of said housing, and means for drawing and extinguishing an arc within said tubular housing including a body of material capable of evolving a gaseous arc extinguishing medium due to the heat of the arc, said body being secured to and disposed within said liner and having a central bore whose diameter is substantially less than that of said liner, and a rod-like terminal filling said bore and movable therethrough on the striking of an arc at one end of said bore between said rod-like terminal and the adjacent tubular terminal and remote from the ends of said tubular housing,

the endwise force resulting from pressure generated by said gaseous arc extinguishing medium and reacting against said body being resisted by the aforesaid construction whereby said tubular terminals are held stationary.

14. The invention, as set forth in claim 13, wherein the tubular housing is formed of a phenolic condensation product and the liner is formed of fibre.

15. In a high voltage circuit interrupter for use with electric power systems wherein the transient recovery voltage may be substantially greater than the normal frequency recovery voltage, in combination, a tubular housing of insulating material having an arcing passageway spaced from each end a distance several times the diameter of said housing, terminals rigidly secured to each end of said tubular housing and projecting beyond the same for connection to the circuit and between which said recovery voltages are applied, a stationary metallic extension from each of said terminals inside said housing extending to the adjacent end of said arcing passageway and projecting beyond the respective end of said housing and rigidly secured to the terminal thereat, insulating tension means within said tubular housing mechanically interlocked at its ends to the inner ends of said extensions to prevent expulsion of the same from said housing, and means for drawing an arc in said passageway on operation of the interrupter, said extensions acting to distribute electrostatic stress between said terminals after interruption of current flow therebetween and prevent the dielectric strength of said arcing passageway from rising above that of any external parallel path between said terminals.

16. In a high voltage circuit interrupter for use with electric power systems wherein the transient recovery voltage may be substantially greater than the normal frequency recovery voltage, in combination, a tubular housing of insulating material having an arcing passageway spaced from each end a distance several times the diameter of said housing, terminals rigidly secured to each end of said tubular housing and projecting beyond the same for connection to the circuit and between which said recovery voltages are applied, a stationary metallic extension from each of said terminals inside said housing extending beyond the respective end of said housing and rigidly secured to the terminal thereat and extending to the adjacent end of said arcing passageway, means for drawing an arc at one end of said arcing passageway on operation of the interrupter including a stationary terminal at said one end of said arcing passageway and a rod-like terminal movable therethrough away from said stationary terminal, separate tubular insulating tension means within and secured to said tubular housing and mechanically interlocked with the extension at said one end of said arcing passageway away from which said rod-like terminal is movable to prevent expulsion of said extension from said housing, said extensions acting to distribute electrostatic stress between said terminals after interruption of current flow therebetween and prevent the dielectric strength of said arcing passageway from rising above that of any external parallel path between said terminals.

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